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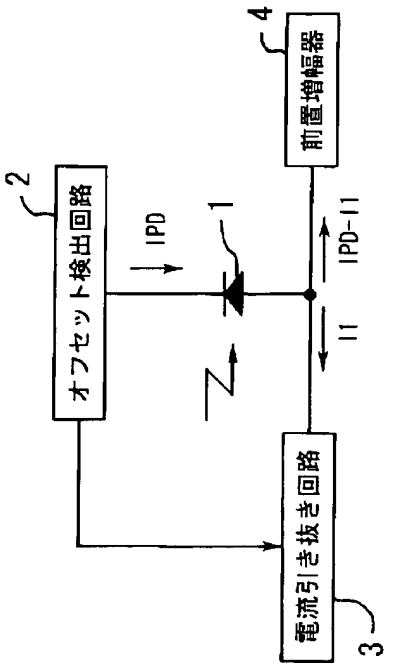
(54)【発明の名称】　光受信装置

(57)【要約】

【課題】　受光素子の低周波応答に起因するオフセットレベル上昇を補償するようにした光受信装置に関し、受光素子のオフセット上昇に伴う振幅識別不能の問題を解決し、かつ、同符号連続入力に対しても振幅識別が可能とし、さらに、構成を簡単にすることを課題とする。

【解決手段】　オフセット検出回路２が、受光素子１の出力した電流量のうちで、光信号のゼロレベルに相当するオフセット電流量を表す電気量を検出し、電流引抜き回路３が、この検出された電気量からオフセット電流量を再生し、再生されたオフセット電流量を、受光素子１の出力した電流量から引抜いたうえで、前置増幅器４へ送る。



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【特許請求の範囲】
【請求項１】　光信号を受信して電気信号に変換する光受信装置において、
入力した光信号を電流量に変換する受光素子と、
前記受光素子の出力した電流量のうちで、光信号のゼロレベルに相当するオフセット電流量を表す電気量を検出するオフセット検出回路と、
前記オフセット検出回路が検出した電気量から前記オフセット電流量を再生し、当該再生されたオフセット電流量を、前記受光素子の出力した電流量から引抜く電流引抜き回路と、
を有することを特徴とする光受信装置。
【請求項２】　前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する電圧バッファと、
前記電圧バッファが出力する電圧値に応じた電流量を発生する電圧制御電流源と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項３】　前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する電圧バッファと、
前記電圧バッファが出力する電圧値を所定の利得量だけ増幅する増幅器と、
前記増幅器の出力値に応じた電流量を発生する電圧制御電流源と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項４】　前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する電圧バッファと、
前記電圧バッファが出力する電圧値を所定の減衰量だけ減衰させる減衰器と、
前記減衰器の出力値に応じた電流量を発生する電圧制御電流源と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項５】　前記オフセット検出回路は、第１の抵抗器とコンデンサとの並列接続回路で構成され、
前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する電圧バッファと、
前記受光素子と前置増幅器との接続点と、前記電圧バッファの出力端との間に接続された第２の抵抗器と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項６】　前記オフセット検出回路は、第１の抵抗器とコンデンサとの並列接続回路で構成され、
前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する第１の電圧バッファと、
前記第１の電圧バッファが出力する電圧値を所定の利得量だけ増幅する増幅器と、
前記増幅器が出力した電圧値の電圧調整を行う第２の電圧バッファと、

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前記受光素子と前置増幅器との接続点と、前記第２の電圧バッファの出力端との間に接続された第２の抵抗器と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項７】　前記オフセット検出回路は、第１の抵抗器とコンデンサとの並列接続回路で構成され、
前記電流引抜き回路は、
前記オフセット検出回路が検出した電気量を調整して電圧値として出力する第１の電圧バッファと、
前記第１の電圧バッファが出力する電圧値を所定の減衰量だけ減衰させる減衰器と、
前記減衰器が出力した電圧値の電圧調整を行う第２の電圧バッファと、
前記受光素子と前置増幅器との接続点と、前記第２の電圧バッファの出力端との間に接続された第２の抵抗器と、
を含むことを特徴とする請求項１記載の光受信装置。
【請求項８】　前置増幅器の出力端に接続され、当該前置増幅器の出力インピーダンスを低インピーダンスに変換するインピーダンス変換回路を、さらに有することを特徴とする請求項１記載の光受信装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、光信号を受信して電気信号に変換する光受信装置に関し、特に、受光素子の低周波応答に起因するオフセットレベル上昇を補償するようにした光受信装置に関する。
【０００２】近年、情報伝送量の増大に伴い光通信が注目されている。そうした光通信において重要な役目を果たす装置として、バルス状の光信号を受信して電気信号に変換する光受信装置がある。
【０００３】
【従来の技術】一般に、光受信装置を構成する受光素子には低周波応答が含まれ、これが原因となって、バルス状の光信号のゼロレベルに相当する、受光素子から出力された電気信号のオフセットレベルが時間経過に伴い上昇する。
【０００４】この低周波応答の原因の１つとして、受光素子の構造が考えられている。すなわち、図１３に一般的な受光素子であるＰＩＮフォトダイオードの断面構造を示すが、この図において、ＰＩＮフォトダイオードは、Ｐ層、Ｉ層（空乏層）、Ｎ層の３層からなり、Ｐ層とＮ層との間にＩ層が挟まれ、Ｐ層とＮ層とに対して電圧が印加される。Ｉ層が受光すると、キャリアが生成され、これがＰ層とＮ層との間にできている電界で加速されて受光素子のアノード側またはカソード側に到達する。これによって、入力光が電気信号に変換される。
【０００５】ところで、印加電極から面方向に離れた部分では電界強度が低くなるが、そうした電界強度が低い

Ｉ層部分にも光が当たることにより、キャリアが生成される。こうしたキャリアは、電界により殆ど加速されることなく、徐々に拡散して受光素子のアノード側またはカソード側に到達する。その結果、受光素子は非常に大きな時定数を持つことになる。この場合の受光素子の周波数応答特性を図１４（Ａ）に示すが、数～数１００ｋＨｚ付近に段差が生ずることとなる。

【０００６】こうした周波数応答特性を持つ受光素子に、図１４（Ｂ）に示すような強度変調が行われた光信号が入力されると、図１４（Ｃ）に示すようなオフセットレベルが時間経過に伴い上昇した電気信号を出力する。

【０００７】受光素子から出力される電気信号のオフセットレベルが時間経過に伴い上昇するために、次のような問題が生じる。先ず第１に、光通信をコンピュータ間のデータ転送に使用した場合を説明する。こうした転送では、比較的伝送距離が短いため、大きなダイナミックレンジを要求されない。したがって、光受信装置の簡単化によるコスト低減を狙い、固定しきい値方式により振幅識別を行う。ところで、オフセットレベルが時間経過に伴い上昇する電気信号を基に、固定しきい値方式により振幅識別を行った場合、図１５（Ａ）に示すように、受光素子から出力される電気信号の「０」レベルが、しきい値を越えてしまうことが生じる。この結果、図１５（Ｂ）に示すように、「０」信号を「１」信号と誤ってしまう（図中に「エラー」と表示）という問題がある。

【０００８】つぎに第２の問題を説明する。光受信装置では、低消費電力を狙って光受信装置の電源電圧を低くすることが行われているが、こうした装置で、受光素子に大振幅信号が入力された場合、受光素子の後段に設けられる前置増幅器が飽和してしまう。これを回避するために、前置増幅器にログアンプ形式が採用されている。すなわち、前置増幅器の入出力特性を、図１６（Ａ）に示すように、一定レベル以上の入力に対してフラットな出力となるようにしている。ところが、図１６（Ｂ）に示すような、振幅が大きく、且つオフセットレベルが時間経過に伴い上昇する信号が、この前置増幅器に入力された場合、図１６（Ｃ）に示すように、本来の「０」レベルが「１」レベルに近づき、ついには「１」レベルと区別がつかない状態になってしまうという問題が生じる。

【０００９】こうした問題を解決した従来技術として、前置増幅器出力の「０」レベル変動を検出し、これを前置増幅器に帰還してオフセットをキャンセルするようにした回路が知られている（１９９５年電子情報通信学会エレクトロニクスソサイエティ大会予稿集Ｃ－５０２）。また、特開平６－２３２９１６号公報および特開平６－２３２９１７号公報に開示された従来技術がある。

【００１０】【発明が解決しようとする課題】しかし、電子情報通信学会エレクトロニクスソサイエティ大会予稿集に掲載の従来技術では、「１」レベルが連続して入力した場合に、「１」レベルを「０」レベルに近づけるように帰還がかかるため、「１」レベルを「０」レベルと誤認する可能性がある。そのため、この従来技術では、同符号連続数を制限する必要がある。また、特開平６－２３２９１６号公報および特開平６－２３２９１７号公報に開示された従来技術では、回路構成が非常に複雑であり、低消費電力化や回路構成の簡略化によるコスト低減等の観点で問題がある。

【００１１】こうしたことから、本発明は、受光素子のオフセット上昇に伴う前述の問題を解決する手段として、こうした従来技術とは異なる他の手段を提供するものである。

【００１２】本発明はこのような点に鑑みてなされたものであり、受光素子のオフセット上昇に伴う振幅識別不能の問題を解決し、かつ、同符号連続入力に対しても振幅識別が可能であり、構成が簡単である光受信装置を提供することを目的とする。

【００１３】【課題を解決するための手段】本発明では上記目的を達成するために、図１に示すように、入力した光信号を電流量に変換する受光素子１と、受光素子１の出力した電流量のうちで、光信号のゼロレベルに相当するオフセット電流量を表す電気量を検出するオフセット検出回路２と、オフセット検出回路２が検出した電気量からオフセット電流量を再生し、再生されたオフセット電流量を、受光素子１の出力した電流量から引抜く電流引抜き回路３とを有することを特徴とする光受信装置が提供される。

【００１４】以上のような構成において、オフセット検出回路２を、抵抗器とコンデンサとの並列接続回路で構成する。これらの並列回路の時定数を適切に選択することにより、オフセット検出回路２は、図２（Ａ）に示すように、受光素子１の出力した電流量ＩＰＤのうちのオフセット電流量Ｉ０のカーブとほぼ相似な電流量カーブＩ２を検出することができる。

【００１５】電流引抜き回路３は、この電流量カーブＩ２を基に、図２（Ｂ）に示すようなオフセット電流量Ｉ０とほぼ同じカーブを有する引抜き電流Ｉ１を作成し（即ち、「オフセット電流量の再生」と同義）、受光素子１の出力した電流量ＩＰＤからこの引抜き電流Ｉ１を引き抜く。この結果、前置増幅器４には、図２（Ｃ）に示すような、オフセットの補償が行われた電流が入力される。

【００１６】また、図３に示すように、「１」レベルが連続して入力された場合でも、オフセット検出回路２は、図３（Ａ）に示すように、受光素子１のオフセット電流量Ｉ０のカーブとほぼ相似な電流量カーブＩ２を検

出することができる。したがって、上記と同様に、電流引抜き回路３は、この電流量カーブＩ２を基に、図３（Ｂ）に示すようなオフセット電流量Ｉ０とほぼ同じカーブを有する引抜き電流Ｉ１を作成し、受光素子１の出力した電流量ＩＰＤからこの引抜き電流Ｉ１を引き抜く。この結果、前置増幅器４には、図３（Ｃ）に示すような、オフセットの補償が行われた電流が入力される。

【００１７】以上のようにして、受光素子１のオフセット上昇に伴う振幅識別不能の問題が解決されるとともに、同符号連続入力に対しても振幅識別が可能であり、また構成が簡単である光受信装置が提供される。

【００１８】

【発明の実施の形態】以下、本発明の実施の形態を図面に基づいて説明する。まず、本発明の光受信装置に係る第１の実施の形態の原理構成を、図１を参照して説明する。第１の実施の形態は、入力した光信号を電流量に変換する受光素子１と、受光素子１の出力した電流量のうちで、光信号のゼロレベルに相当するオフセット電流量を表す電気量を検出するオフセット検出回路２と、オフセット検出回路２が検出した電気量からオフセット電流量を再生し、再生されたオフセット電流量を、受光素子１の出力した電流量から引抜く電流引抜き回路３とを備える。

【００１９】図４は、第１の実施の形態の詳しい構成を示すブロック図である。図中、電流引抜き回路３が電圧バッファ３ａと電圧制御電流源３ｂとから構成される。このブロック図に対応する回路図を図５に示す。

【００２０】図５において、受光素子１はＰＩＮフォトダイオードＰＤで構成され、フォトダイオードＰＤのカソード側にオフセット検出回路２が接続される。オフセット検出回路２は、可変抵抗Ｒ１とコンデンサＣ１との並列接続回路となっている。フォトダイオードＰＤのアノード側は、前置増幅器４の入力端であるトランジスタＱ３のベースに接続される。受光素子１とオフセット検出回路２との接続点が、電圧バッファ３ａの入力端であるトランジスタＱ１のベースに、抵抗Ｒ２を介して接続される。電圧バッファ３ａはエミッタフォロアで構成される。電圧バッファ３ａの出力端は、電圧制御電流源３ｂの入力端であるトランジスタＱ２のベースに接続される。電圧制御電流源３ｂのトランジスタＱ２のコレクタは、前置増幅器４のトランジスタＱ３のベースに接続される。

【００２１】つぎに図５の回路の動作を説明する。可変抵抗Ｒ１とコンデンサＣ１との並列接続回路は、図２（Ａ）に示したように、フォトダイオードＰＤに流れる電流ＩＰＤを積分して、電流量カーブＩ２に相当する電圧値を検出する。この電流量カーブＩ２の形状は、可変抵抗Ｒ１の抵抗値を変化させることによって変化するので、この電流量カーブＩ２の形状がフォトダイオードＰＤのオフセット電流量Ｉ０のカーブと相似となるように、可変抵抗Ｒ１の抵抗値を調整する。実際には、前置増幅器４の出力を監視して、図２（Ｃ）のような波形が得られるように、可変抵抗Ｒ１の抵抗値を調整する。

【００２２】電流量カーブＩ２に相当する電圧が、電圧バッファ３ａのトランジスタＱ１のベースに入力されると、トランジスタＱ１のエミッタに接続されたダイオードＤ１と抵抗Ｒ３との接続点には、図２（Ｂ）に示す引抜き電流Ｉ１に相当する電圧が発生する。この電圧に応じて電圧制御電流源３ｂのトランジスタＱ２が電流を発生する。この電流が、図２（Ｂ）の引抜き電流Ｉ１に相当する。引抜き電流Ｉ１は、トランジスタＱ２のコレクタに流入する方向に流れるので、フォトダイオードＰＤから前置増幅器４のトランジスタＱ３のベースに流れる筈の電流ＩＰＤから、引抜き電流Ｉ１だけが差し引かれた電流（ＩＰＤ－Ｉ１）がトランジスタＱ３のベースに流れることになる。

【００２３】前置増幅器４はトランスインピーダンス型の通常の構成である。ダイオードＤ４は、大振幅信号の入力によって飽和することを防ぐために設けられたログアンプ形式を構成するダイオードであり、ダイオードＤ３は大振幅信号の入力による発振を防止するためのダイオードである。

【００２４】以上のようにして、フォトダイオードＰＤのオフセット電流量Ｉ０の上昇に伴う振幅識別不能の問題が解決されるとともに、同符号連続入力に対しても、引抜き電流Ｉ１の形状をオフセット電流量Ｉ０の形状とほぼ同じにすることができるので、振幅識別が可能である。その上、回路構成が簡単であり、ＩＣ化も容易に実現可能である。

【００２５】つぎに、第２の実施の形態を説明する。図６は第２の実施の形態の構成を示すブロック図であり、図７はこのブロック図に対応する回路図である。なお、第２の実施の形態の構成は、第１の実施の形態の構成と基本的には同じであるので、同じ構成部分には同じ参照符号を付してその説明を省略する。

【００２６】第２の実施の形態では、第１の実施の形態の構成に、電圧バッファ３ｃと増幅器３ｄとを新たに追加する。すなわち、図６に示すように、電圧バッファ３ｃと増幅器３ｄとを、オフセット検出回路２と電圧バッファ３ａとの間に追加する。回路構成で説明すれば、図７に示すように、受光素子１とオフセット検出回路２との接続点が、電圧バッファ３ｃの入力端であるトランジスタＱ５のベースに抵抗Ｒ９を介して接続される。電圧バッファ３ｃの出力端は、増幅器３ｄの入力端であるトランジスタＱ６のベースに接続される。増幅器３ｄの出力端であるトランジスタＱ７のコレクタは、電圧バッファ３ａのトランジスタＱ１のベースに接続される。増幅器３ｄは、可変抵抗Ｒ１６の抵抗値を可変することにより利得を可変できる差動増幅器である。

【００２７】こうした、電圧バッファ３ｃと増幅器３ｄ

とを追加し、増幅器３ｄの増幅量を調整することにより、電圧制御電流源３ｂで発生する引抜き電流Ｉ１の大きさを調整することができる。

【００２８】なお、第２の実施の形態では増幅器３ｄを追加して、引抜き電流Ｉ１の大きさを増やす方向で調整しているが、引抜き電流Ｉ１の形状とフォトダイオードＰＤのオフセット電流量Ｉ０の形状との大小関係によっては、増幅器３ｄに代わって、減衰量を可変できる減衰器を設け、引抜き電流Ｉ１の大きさを減らす方向で調整するようにした方がよい場合もあり得る。

【００２９】つぎに、第３の実施の形態を説明する。図８は第３の実施の形態の構成を示すブロック図であり、図９はこのブロック図に対応する回路図である。第３の実施の形態の構成は、第１の実施の形態の構成と基本的には同じであるので、同じ構成部分には同じ参照符号を付してその説明を省略する。

【００３０】第３の実施の形態では、第１の実施の形態の電流引抜き回路３が、電圧バッファ３ｅと抵抗Ｒ２０とで構成される。回路構成で説明すれば、図９に示すように、受光素子１とオフセット検出回路２との接続点が、電圧バッファ３ｅの入力端であるトランジスタＱ１０のベースに、抵抗Ｒ２１を介して接続される。電圧バッファ３ｅの出力端は抵抗Ｒ２０の一端に接続され、抵抗Ｒ２０の他端は、前置増幅器４のトランジスタＱ３のベースに接続される。

【００３１】つぎに、前置増幅器４のトランジスタＱ３のベースに流れこむ筈の電流量ＩＰＤから、抵抗Ｒ２０を介して引き抜かれる引抜き電流Ｉ１について説明する。すなわち、オフセット検出回路２で電圧ΔＶの出力が得られ、それが電圧バッファ３ｅに入力したとする。電圧バッファ３ｅは原理的に利得が「１」であるので、抵抗Ｒ２０の一端には電圧ΔＶがそのまま伝わる。一方、前置増幅器４はトランスインピーダンス型であるため、抵抗Ｒ７により帰還がかかっており、したがって、抵抗Ｒ２０の他端の電位は変動しない。これにより、抵抗Ｒ２０には電圧ΔＶがかかることになり、引抜き電流Ｉ１はΔＶ／Ｒ２０となる。ここで、ΔＶ∝Ｒ１の関係にあるので、Ｉ１∝Ｒ１／Ｒ２０となる。よって、引抜き電流Ｉ１の大きさは、抵抗Ｒ１と抵抗Ｒ２０との比によって設定できる。

【００３２】つぎに、第４の実施の形態を説明する。図１０は第４の実施の形態の構成を示すブロック図であり、図１１はこのブロック図に対応する回路図である。第４の実施の形態の構成は、第３の実施の形態に、第２の実施の形態の電圧バッファ３ｃと増幅器３ｄとを新たに追加したものである。したがって、第４の実施の形態の説明では、第３の実施の形態および第２の実施の形態の構成と同じ部分には同じ参照符号を付して、その説明を省略する。

【００３３】第４の実施の形態では、増幅器３ｄによって引抜き電流Ｉ１の大きさを調整することができるので、抵抗Ｒ２０の抵抗値は固定であってよい。抵抗Ｒ２０を固定抵抗器にすることにより、帯域を狭くする分布容量を無くすことができ、また、ＩＣ化し易い構成となる。

【００３４】なお、第４の実施の形態でも、増幅器３ｄに代わって、減衰量を可変できる減衰器を設け、引抜き電流Ｉ１の大きさを減らす方向で調整するようにしてもよい。

【００３５】つぎに、第５の実施の形態を説明する。図１２は第５の実施の形態の構成を示すブロック図である。すなわち、上記のいずれの実施の形態においても、図２や図３に示す引抜き電流Ｉ１の形状を、フォトダイオードＰＤのオフセット電流量Ｉ０の形状に近づける調整が必要であるが、この調整は、実際には前置増幅器４の出力を監視して、図２（Ｃ）のような波形が得られるように行われる。しかし、前置増幅器４の出力インピーダンスは高く、一方、出力監視用のオシロスコープ等の測定器６では、高周波数の信号を扱うためには入力インピーダンスが低い必要があり、このままでは前置増幅器４の出力監視ができないという事情があった。そこで、前置増幅器４の出力端を分岐して、分岐された出力端にインピーダンス変換回路５を設けるようにする。このインピーダンス変換回路５によって、前置増幅器４の出力インピーダンスを、例えば５０Ω程度の低出力インピーダンスに変換して、低入力インピーダンスの測定器６を接続するようにする。これにより、容易に上記引抜き電流Ｉ１の調整ができるとともに、光信号の監視等も可能となる。

【００３６】なお、上述した各実施の形態では、図５、図７、図９、図１１、および図１２で具体的回路を示したが、これは例示しただけに過ぎず、同一の機能を達成する回路であれば他の回路構成であってもよい。

【００３７】また、上述した各実施の形態では、オフセット検出回路２をコンデンサＣ１と抵抗Ｒ１との並列回路で構成しているが、フォトダイオードＰＤの特性に応じて、オフセット検出回路２を、こうした並列回路を複数、直列に接続して構成するようにしてもよい。

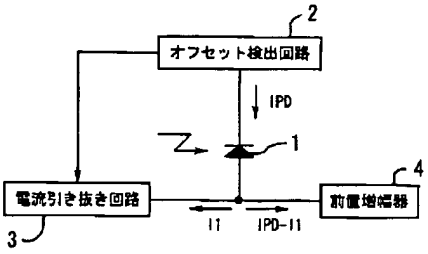
【００３８】

【発明の効果】以上説明したように本発明では、受光素子の出力した電流量のうちで、光信号のゼロレベルに相当するオフセット電流量を表す電気量を検出し、これを基に、オフセット電流量を再生する。そして、再生されたオフセット電流量を、受光素子の出力した電流量から引抜くようにする。

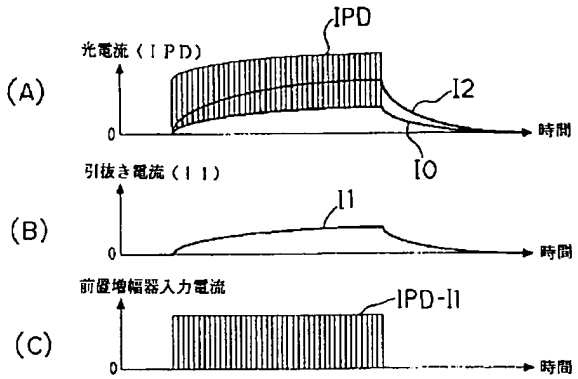
【００３９】これにより、受光素子のオフセットが上昇しても振幅識別ができ、また、同符号連続入力に対しても振幅識別ができるとともに、回路構成が非常に簡単となり、また消費電力の低い光受信装置を提供することが可能となる。

【図面の簡単な説明】
【図１】本発明の原理説明図である。
【図２】（Ａ）は受光素子から出力される電流を示す図であり、（Ｂ）は本発明によって発生される引抜き電流を示す図であり、（Ｃ）は本発明における前置増幅器に入力される電流を示す図である。
【図３】（Ａ）は同符号連続入力時に受光素子から出力される電流を示す図であり、（Ｂ）は同符号連続入力時に本発明によって発生される引抜き電流を示す図であり、（Ｃ）は同符号連続入力時に本発明における前置増幅器に入力される電流を示す図である。
【図４】第１の実施の形態の構成を示すブロック図である。
【図５】第１の実施の形態の回路構成を示す図である。
【図６】第２の実施の形態の構成を示すブロック図である。
【図７】第２の実施の形態の回路構成を示す図である。
【図８】第３の実施の形態の構成を示すブロック図である。
【図９】第３の実施の形態の回路構成を示す図である。
【図１０】第４の実施の形態の構成を示すブロック図である。
【図１１】第４の実施の形態の回路構成を示す図である。
＊【図１２】第５の実施の形態の構成を示すブロック図である。
【図１３】ＰＩＮダイオードの断面構造を示す図である。
【図１４】（Ａ）は受光素子の周波数応答特性を示す図であり、（Ｂ）は受光素子に入力する光信号を示す図であり、（Ｃ）は受光素子から出力された電気信号を示す図である。
【図１５】（Ａ）は受光素子の出力と、振幅識別用のしきい値との従来の関係を示す図であり、（Ｂ）は従来の振幅識別器の出力を示す図である。
【図１６】（Ａ）は従来のログアンプ形式の前置増幅器の入出力特性を示す図であり、（Ｂ）はこの前置増幅器に入力される従来の大振幅信号の波形を示す図であり、（Ｃ）はこの前置増幅器から出力された従来の信号波形を示す図である。
【符号の説明】
１　受光素子
２　オフセット検出回路
３　電流引抜き回路
４　前置増幅器
ＩＰＤ　受光素子の出力電流
Ｉ１　引抜き電流
＊

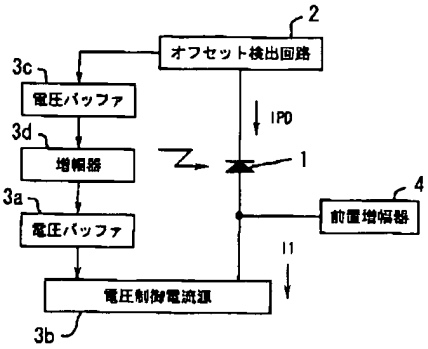
【図１】



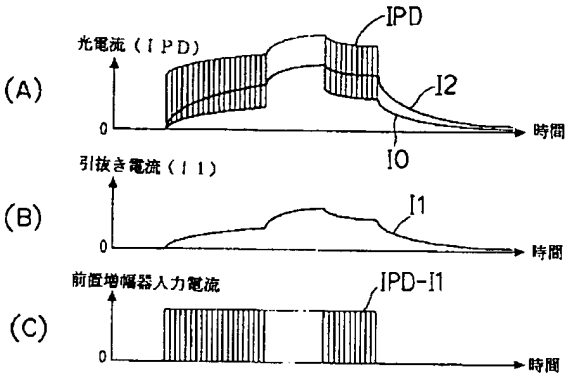

【図２】



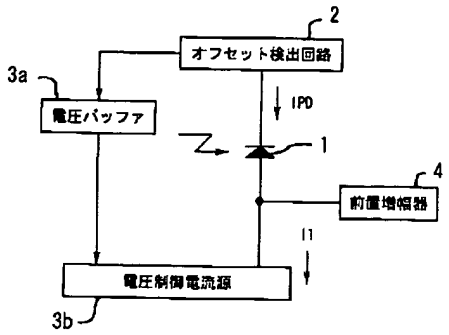

【図６】



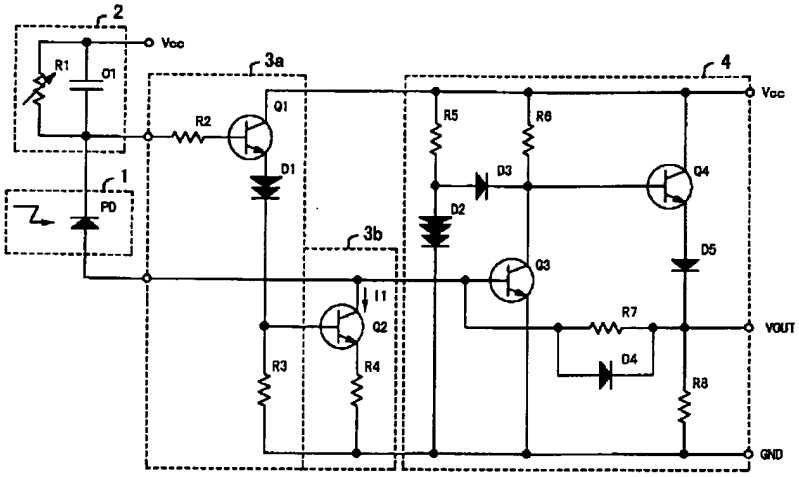
【図３】


(A)
光電流（ＩＰＤ）
IPD
I2
I0
時間
0
(B)
引抜き電流（Ｉ１）
I1
時間
0
(C)
前置増幅器入力電流
IPD-I1
時間
0

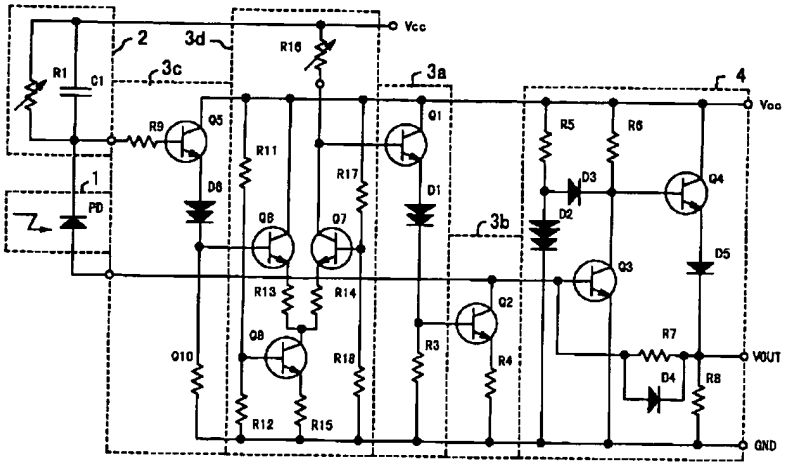
【図４】


2
オフセット検出回路
3a
電圧バッファ
IPD
1
4
前置増幅器
I1
電圧制御電流源
3b

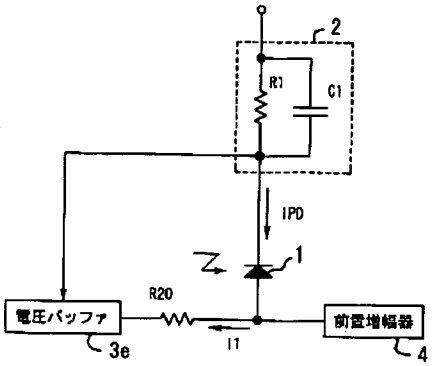
【図５】


2
Vcc
R1
C1
3a
Q1
R2
D1
1
PD
3b
I1
Q2
R3
R4
4
Vcc
R5
R6
D3
Q4
D2
Q3
D5
R7
VOUT
D4
R8
GND

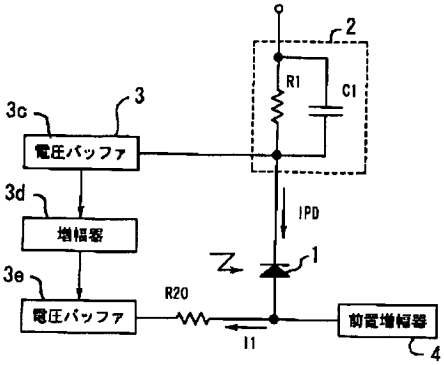
【図７】


Vcc
2
3d
R16
R1
C1
3c
3a
4
Vcc
R9
Q5
R11
Q1
R5
R6
R17
D3
Q4
1
PD
D6
D1
D2
3b
Q6
Q7
D5
Q3
R13
R14
Q2
Q8
R7
Q10
R18
R3
R4
VOUT
D4
R8
R12
R15
GND

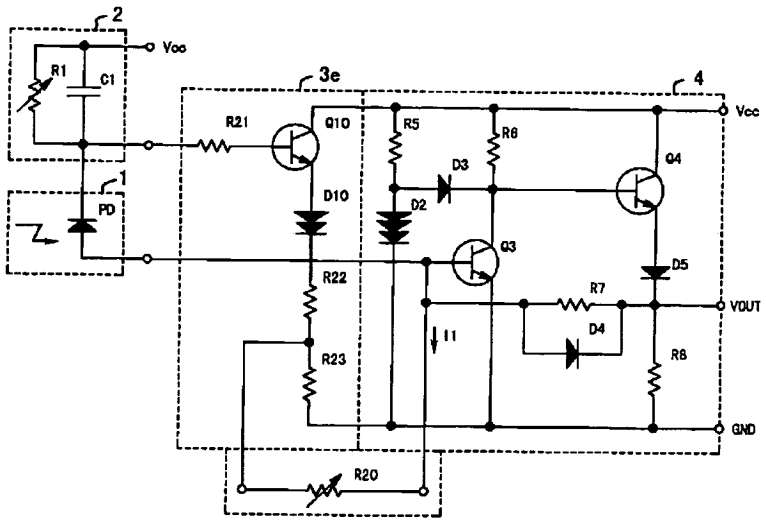
【図８】



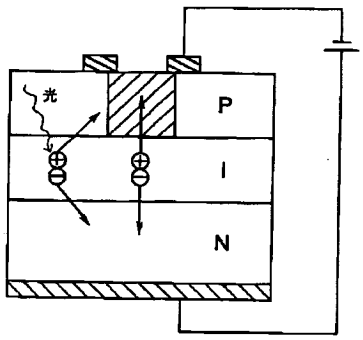

【図１０】



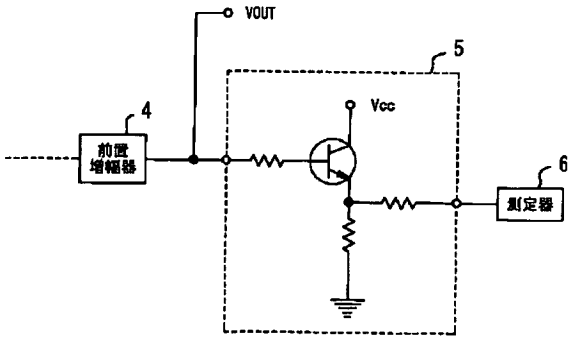

【図９】



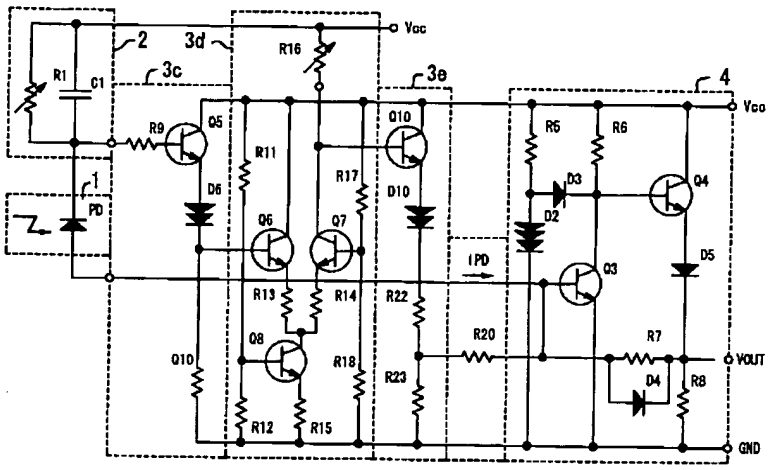

【図１３】



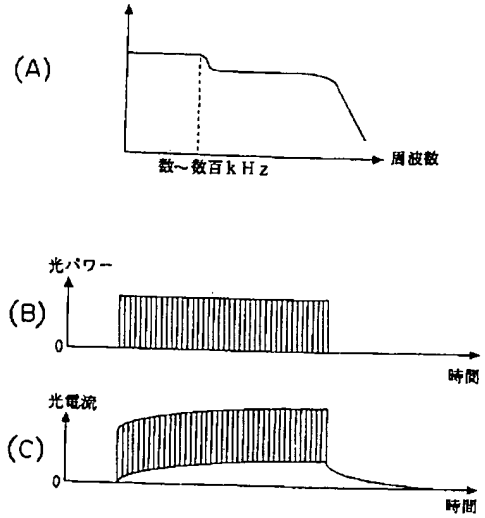

【図１２】



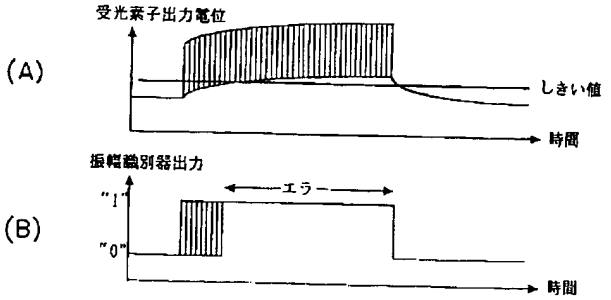
【図１１】



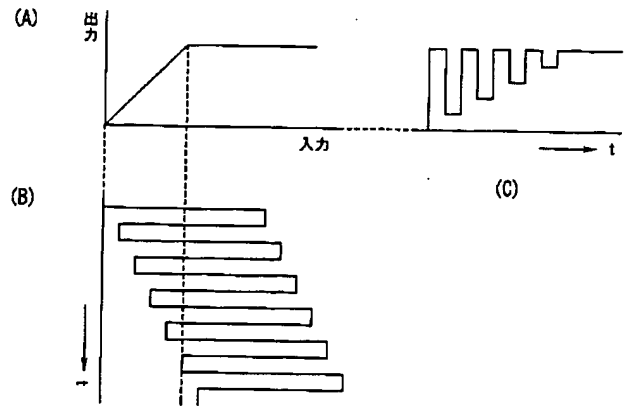

【図１４】




【図１５】




【図１６】



フロントページの続き

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|---|---|---|---|---|
| Ｈ０４Ｂ　10/06 | | | | |
| Ｈ０４Ｌ　25/03 | | | | |

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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CLAIMS

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[Claim(s)]
[Claim 1] In the optical receiving set which receives a lightwave signal and is changed into an electrical signal, the inputted lightwave signal among the amounts of currents which the photo detector changed into the amount of currents and said photo detector outputted The offset detector which detects quantity of electricity showing the amount of offset currents equivalent to the zero level of a lightwave signal, The optical receiving set characterized by having the current drawing circuit drawn out from the amount of currents to which said amount of offset currents was reproduced from quantity of electricity which said offset detector detected, and said photo detector outputted the reproduced amount of offset currents concerned.
[Claim 2] Said current drawing circuit is an optical receiving set according to claim 1 characterized by including the electrical-potential-difference buffer which adjusts quantity of electricity which said offset detector detected, and is outputted as an electrical-potential-difference value, and the armature-voltage control current source which generates the amount of currents according to the electrical-potential-difference value which said electrical-potential-difference buffer outputs.
[Claim 3] Said current drawing circuit is an optical receiving set according to claim 1 characterized by including the electrical-potential-difference buffer which adjusts quantity of electricity which said offset detector detected, and is outputted as an electrical-potential-difference value, the amplifier with which only the predetermined amount of gains amplifies the electrical-potential-difference value which said electrical-potential-difference buffer outputs, and the armature-voltage control current source which generates the amount of currents according to the output value of said amplifier.
[Claim 4] Said current drawing circuit is an optical receiving set according to claim 1 characterized by including the electrical-potential-difference buffer which adjusts quantity of electricity which said offset detector detected, and is outputted as an electrical-potential-difference value, the attenuator with which only the predetermined magnitude of attenuation attenuates the electrical-potential-difference value which said electrical-potential-difference buffer outputs, and the armature-voltage control current source which generates the amount of currents according to the output value of said attenuator.
[Claim 5] It is the optical receiving set according to claim 1 characterized by including the 2nd resistor connected between the node of the electrical-potential-difference buffer which said offset detector consists of parallel connection circuits of the 1st resistor and a capacitor, and adjusts quantity of electricity to which said offset detector detected said current drawing circuit, and outputs it as an electrical-potential-difference value, and said photo detector and preamp, and the outgoing end of said electrical-potential-difference buffer.
[Claim 6] Said offset detector consists of parallel connection circuits of the 1st resistor and a capacitor. Said current drawing circuit The 1st electrical-potential-difference buffer which adjusts quantity of electricity which said offset detector detected, and is outputted as an electrical-potential-difference value, The amplifier with which only the predetermined amount of gains amplifies the electrical-potential-difference value which said 1st electrical-potential-difference buffer outputs, The optical receiving set according to claim 1 characterized by including the 2nd resistor connected between the

node of the 2nd electrical-potential-difference buffer which performs voltage adjustment of the electrical-potential-difference value which said amplifier outputted, and said photo detector and preamp, and the outgoing end of said 2nd electrical-potential-difference buffer.
[Claim 7] Said offset detector consists of parallel connection circuits of the 1st resistor and a capacitor. Said current drawing circuit The 1st electrical-potential-difference buffer which adjusts quantity of electricity which said offset detector detected, and is outputted as an electrical-potential-difference value, The attenuator with which only the predetermined magnitude of attenuation attenuates the electrical-potential-difference value which said 1st electrical-potential-difference buffer outputs, The optical receiving set according to claim 1 characterized by including the 2nd resistor connected between the node of the 2nd electrical-potential-difference buffer which performs voltage adjustment of the electrical-potential-difference value which said attenuator outputted, and said photo detector and preamp, and the outgoing end of said 2nd electrical-potential-difference buffer.
[Claim 8] The optical receiving set according to claim 1 characterized by having further the impedance-conversion circuit which is connected to the outgoing end of a preamp and changes the output impedance of the preamp concerned into low impedance.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical receiving set with which the offset level rise which originates in the AF response of a photo detector especially was compensated about the optical receiving set which receives a lightwave signal and is changed into an electrical signal.
[0002] In recent years, optical communication attracts attention with increase of the amount of information transmissions. There is an optical receiving set which receives a pulse-like lightwave signal and is changed into an electrical signal as equipment which achieves an important duty in such optical communication.
[0003]
[Description of the Prior Art] Generally an AF response is included in the photo detector which constitutes an optical receiving set, this becomes a cause and the offset level of the electrical signal outputted from the photo detector equivalent to the zero level of a pulse-like lightwave signal rises with time amount progress.
[0004] The structure of a photo detector is considered as one of the causes of this AF response. That is, although the cross-section structure of the PIN photodiode which is a photo detector general to drawing 13 is shown, in this drawing, an PIN photodiode consists of three layers, P layers, I layers (depletion layer), and N layer, I layers are inserted between P layers and N layer, and an electrical potential difference is impressed to P layers and N layer. If I layers receive light, a carrier will be generated, it will be accelerated by the electric field by which this is made between P layers and N layer, and an anode [ of a photo detector ] or cathode side will be reached. Input light is changed into an electrical signal by this.
[0005] By the way, although field strength becomes low in the part separated from the impression electrode in the direction of a field, a carrier is generated when light is also equivalent to an I layer part with such low field strength. Without almost being accelerated by electric field, such a carrier is diffused gradually and reaches an anode [ of a photo detector ], or cathode side. Consequently, a photo detector will have a very big time constant. Although the frequency response characteristic of the photo detector in this case is shown in drawing 14 (A), a level difference will arise near a number - 100kHz of numbers.
[0006] If the lightwave signal with which intensity modulation as shown in drawing 14 (B) was performed is inputted into a photo detector with such a frequency response characteristic, an offset level as shown in drawing 14 (C) will output the electrical signal which went up with time amount progress.
[0007] Since the offset level of the electrical signal outputted from a photo detector rises with time amount progress, the following problems arise. The case where 1st optical communication is first used for the data transfer between computers is explained. Since the transmission distance is comparatively short, such a transfer does not require a big dynamic range. Therefore, the cost reduction by simplification of an optical receiving set is aimed at, and a fixed threshold method performs amplitude discernment. By the way, when a fixed threshold method performs amplitude discernment based on the

electrical signal with which an offset level rises with time amount progress, as shown in drawing 15 (A), it arises that "0" level of the electrical signal outputted from a photo detector exceeds a threshold. Consequently, as shown in drawing 15 (B), there is a problem of mistaking "0" signals for "1" signal (it being displayed as "an error" all over drawing).

[0008] The 2nd problem is explained below. Although aiming at a low power and making supply voltage of an optical receiving set low is performed, when a large amplitude signal is inputted into a photo detector, the preamp formed in the latter part of a photo detector will be saturated with an optical receiving set with such equipment. In order to avoid this, the logarithmic amplifier format is adopted as the preamp. That is, the input-output behavioral characteristics of a preamp are made to become a flat output to the input more than fixed level, as shown in drawing 16 (A). however, when the signal with which the amplitude as shown in drawing 16 (B) is large with a signal, and an offset level rises with time amount progress is inputted into this preamp, it is shown in drawing 16 (C) -- as -- original "0" level -- "1" -- level -- approaching -- just -- being alike -- the problem of being in the condition that "1" level and distinction do not stick arises.

[0009] The circuit which detects "0" level variation of a preamp output, returns this to a preamp as a conventional technique which solved such a problem, and canceled offset is known (collection C-502 of the 1995 Institute of Electronics, Information and Communication Engineers electronics society convention drafts). Moreover, there is the conventional technique indicated by JP,6-232916,A and JP,6-232917,A.

[0010]

[Problem(s) to be Solved by the Invention] However, found in the collection of the Institute of Electronics, Information and Communication Engineers electronics society convention drafts, with the conventional technique, since feedback starts so that "1" level may be brought close to "0" level when "1" level inputs continuously, "1" level may be taken for "0" level. Therefore, it is necessary to restrict the number of same sign continuation with this conventional technique. Moreover, in the conventional technique indicated by JP,6-232916,A and JP,6-232917,A, circuitry is very complicated and there is a problem in viewpoints, such as cost reduction by low-power-izing or simplification of circuitry.

[0011] From such a thing, this invention offers other different means from such a conventional technique as a means to solve the above-mentioned problem accompanying an offset rise of a photo detector.

[0012] This invention is made in view of such a point, the problem of the amplitude discernment impossible accompanying an offset rise of a photo detector is solved, and also to a same sign continuation input, amplitude discernment is possible and a configuration aims at offering an easy optical receiving set.

[0013]

[Means for Solving the Problem] In order to attain the above-mentioned purpose in this invention, as shown in drawing 1 , the inputted lightwave signal among the amounts of currents which the photo detector 1 changed into the amount of currents and the photo detector 1 outputted The offset detector 2 which detects quantity of electricity showing the amount of offset currents equivalent to the zero level of a lightwave signal, The optical receiving set characterized by having the current drawing circuit 3 which reproduces the amount of offset currents from quantity of electricity which the offset detector 2 detected, and draws out the reproduced amount of offset currents from the amount of currents which the photo detector 1 outputted is offered.

[0014] In the above configurations, the offset detector 2 consists of parallel connection circuits of a resistor and a capacitor. By choosing the time constant of these parallel circuits appropriately, the offset detector 2 can detect the amount curve [ **** / the curve of the amount I0 of offset currents of the amounts IPD of currents which the photo detector 1 outputted / almost ] I2 of currents, as shown in drawing 2 (A).

[0015] The current drawing circuit 3 creates the drawing current I1 which has the almost same curve as the amount I0 of offset currents as shown in drawing 2 (B) based on this amount curve I2 of currents (namely, "playback of the amount of offset currents" and homonymy), and draws out this drawing

current I1 from the amount IPD of currents which the photo detector 1 outputted. Consequently, the current to which compensation of offset as shown in drawing 2 (C) was carried out is inputted into a preamp 4.

[0016] Moreover, as shown in drawing 3 , even when "1" level is inputted continuously, as shown in drawing 3 (A), as for the offset detector 2, the amount curve [ **** / the curve of the amount I0 of offset currents of a photo detector 1 / almost ] I2 of currents can be detected. Therefore, like the above, the current drawing circuit 3 creates the drawing current I1 which has the almost same curve as the amount I0 of offset currents as shown in drawing 3 (B) based on this amount curve I2 of currents, and draws out this drawing current I1 from the amount IPD of currents which the photo detector 1 outputted. Consequently, the current to which compensation of offset as shown in drawing 3 (C) was carried out is inputted into a preamp 4.

[0017] While the problem of the amplitude discernment impossible accompanying an offset rise of a photo detector 1 as mentioned above is solved, an optical receiving set with an easy configuration is offered possible [ amplitude discernment ] also to a same sign continuation input.

[0018]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. First, the principle configuration of the gestalt of the 1st operation concerning the optical receiving set of this invention is explained with reference to drawing 1 . The gestalt of the 1st operation is equipped with the current drawing circuit 3 which reproduces the amount of offset currents from quantity of electricity which the offset detector 2 which detects quantity of electricity which expresses the amount of offset currents equivalent to the zero level of a lightwave signal among the amounts of currents which the photo detector 1 which changes the inputted lightwave signal into the amount of currents, and the photo detector 1 outputted, and an offset detector 2 detected, and draws out the reproduced amount of offset currents from the amount of currents which a photo detector 1 outputted.

[0019] Drawing 4 is the block diagram showing the 1st detailed configuration of the gestalt of operation. The current drawing circuit 3 consists of electrical-potential-difference buffer 3a and armature-voltage control current source 3b among drawing. The circuit diagram corresponding to this block diagram is shown in drawing 5 .

[0020] In drawing 5 , a photo detector 1 consists of PIN photodiodes PD, and the offset detector 2 is connected to the cathode side of Photodiode PD. The offset detector 2 is the parallel connection circuit of variable resistance R1 and a capacitor C1. The anode side of Photodiode PD is connected to the base of the transistor Q3 which is the input edge of a preamp 4. The node of a photo detector 1 and the offset detector 2 is connected to the base of the transistor Q1 which is the input edge of electrical-potential-difference buffer 3a through resistance R2. Electrical-potential-difference buffer 3a consists of emitter-followers. The outgoing end of electrical-potential-difference buffer 3a is connected to the base of the transistor Q2 which is the input edge of armature-voltage control current source 3b. The collector of the transistor Q2 of armature-voltage control current source 3b is connected to the base of the transistor Q3 of a preamp 4.

[0021] Actuation of the circuit of drawing 5 is explained below. As shown in drawing 2 (A), the parallel connection circuit of variable resistance R1 and a capacitor C1 integrates with the current IPD which flows to Photodiode PD, and detects the electrical-potential-difference value equivalent to the amount curve I2 of currents. Since the configuration of this amount curve I2 of currents changes by changing the resistance of variable resistance R1, it adjusts the resistance of variable resistance R1 so that the configuration of this amount curve I2 of currents may serve as a curve of the amount I0 of offset currents of Photodiode PD, and similarity. In fact, the output of a preamp 4 is supervised, and the resistance of variable resistance R1 is adjusted so that a wave like drawing 2 (C) may be acquired.

[0022] If the electrical potential difference equivalent to the amount curve I2 of currents is inputted into the base of the transistor Q1 of electrical-potential-difference buffer 3a, the electrical potential difference equivalent to the drawing current I1 shown in drawing 2 (B) will occur at the node of the diode D1 connected to the emitter of a transistor Q1, and resistance R3. According to this electrical potential difference, the transistor Q2 of armature-voltage control current source 3b generates a current.

This current is equivalent to the drawing current I1 of drawing 2 (B). Since the drawing current I1 flows in the direction which flows into the collector of a transistor Q2, the current (IPD-I1) from which only the drawing current I1 was deducted will flow at the base of a transistor Q3 from the current IPD which should flow at the base of the transistor Q3 of a preamp 4 from Photodiode PD.

[0023] A preamp 4 is the usual configuration of a transimpedance mold. It is the diode which constitutes the logarithmic amplifier format established in order to prevent saturating diode D4 by the input of a large amplitude signal, and diode D3 is the diode for preventing the oscillation by the input of a large amplitude signal.

[0024] Since the configuration of the drawing current I1 can be made almost the same as the configuration of the amount I0 of offset currents also to a same sign continuation input while the problem of the amplitude discernment impossible accompanying the rise of the amount I0 of offset currents of Photodiode PD as mentioned above is solved, amplitude discernment is possible. Moreover, circuitry is easy and IC-ization can also be realized easily.

[0025] Below, the gestalt of the 2nd operation is explained. Drawing 6 R> 6 is the block diagram showing the 2nd configuration of the gestalt of operation, and drawing 7 is a circuit diagram corresponding to this block diagram. In addition, since the 2nd configuration of the gestalt of operation is fundamentally [ as the 1st configuration of the gestalt of operation ] the same, it gives the same reference mark to the same component, and omits the explanation.

[0026] With the gestalt of the 2nd operation, electrical-potential-difference buffer 3c and 3d of amplifier are newly added to the 1st configuration of the gestalt of operation. That is, as shown in drawing 6 , electrical-potential-difference buffer 3c and 3d of amplifiers are added between the offset detector 2 and electrical-potential-difference buffer 3a. If circuitry explains, as shown in drawing 7 R> 7, the node of a photo detector 1 and the offset detector 2 will be connected to the base of the transistor Q5 which is the input edge of electrical-potential-difference buffer 3c through resistance R9. The outgoing end of electrical-potential-difference buffer 3c is connected to the base of the transistor Q6 which is the input edge of 3d of amplifiers. The collector of the transistor Q7 which is the outgoing end of 3d of amplifiers is connected to the base of the transistor Q1 of electrical-potential-difference buffer 3a. 3d of amplifier is the differential amplifier which can carry out adjustable [ of the gain ] by carrying out adjustable [ of the resistance of variable resistance R16 ].

[0027] The magnitude of the drawing current I1 generated in armature-voltage control current source 3b can be adjusted by adding such electrical-potential-difference buffer 3c and 3d of amplifier, and adjusting the amount of magnification of 3d of amplifier.

[0028] In addition, although adjusted with the gestalt of the 2nd operation towards adding 3d of amplifier and increasing the magnitude of the drawing current I1 It may be better to have made it adjust towards forming the attenuator which can carry out adjustable [ of the magnitude of attenuation ] depending on the size relation between the configuration of the drawing current I1, and the configuration of the amount I0 of offset currents of Photodiode PD instead of 3d of amplifier, and reducing the magnitude of the drawing current I1.

[0029] Below, the gestalt of the 3rd operation is explained. Drawing 8 R> 8 is the block diagram showing the 3rd configuration of the gestalt of operation, and drawing 9 is a circuit diagram corresponding to this block diagram. Since the 3rd configuration of the gestalt of operation is fundamentally [ as the 1st configuration of the gestalt of operation ] the same, it gives the same reference mark to the same component, and omits the explanation.

[0030] The current drawing circuit 3 of the gestalt of the 1st operation is constituted from electrical-potential-difference buffer 3e and resistance R20 by the gestalt of the 3rd operation. If circuitry explains, as shown in drawing 9 , the node of a photo detector 1 and the offset detector 2 will be connected to the base of the transistor Q10 which is the input edge of electrical-potential-difference buffer 3e through resistance R21. The outgoing end of electrical-potential-difference buffer 3e is connected to the end of resistance R20, and the other end of resistance R20 is connected to the base of the transistor Q3 of a preamp 4.

[0031] Below, the drawing current I1 drawn out through resistance R20 is explained from the amount

IPD of currents which should flow into the base of the transistor Q3 of a preamp 4. That is, the output of electrical-potential-difference deltaV is obtained in the offset detector 2, and suppose that it inputted into electrical-potential-difference buffer 3e. Since the gain of electrical-potential-difference buffer 3e is "1" theoretically, electrical-potential-difference deltaV gets across to the end of resistance R20 as it is. On the other hand, since a preamp 4 is a transimpedance mold, feedback has started by resistance R7, therefore the potential of the other end of resistance R20 is not changed. Thereby, electrical-potential-difference deltaV will start resistance R20, and the drawing current I1 serves as deltaV/R20. Here, since it has the relation of deltaV**R1, it is set to I1**R1/R20. Therefore, the magnitude of the drawing current I1 can be set up by the ratio of resistance R1 and resistance R20.

[0032] Below, the gestalt of the 4th operation is explained. Drawing 1010 is a block diagram showing the 4th configuration of the gestalt of operation, and drawing 11 is a circuit diagram corresponding to this block diagram. The 4th configuration of the gestalt of operation newly adds electrical-potential-difference buffer 3c of the gestalt of the 2nd operation, and 3d of amplifier to the gestalt of the 3rd operation. Therefore, in explanation of the gestalt of the 4th operation, the same reference mark is given to the same part as the configuration of the gestalt of the 3rd operation, and the gestalt of the 2nd operation, and the explanation is omitted.

[0033] Since 3d of amplifier can draw out and the magnitude of a current I1 can be adjusted with the gestalt of the 4th operation, the resistance of resistance R20 may be immobilization. By using resistance R20 as a fixed resistor, it becomes the configuration which can lose the distributed capacity which narrows a band andis [ IC-] easy toize.

[0034] In addition, the attenuator which can carry out adjustable [ of the magnitude of attenuation ] instead of 3d of amplifier also with the gestalt of the 4th operation is formed, and you may make it adjust towards reducing the magnitude of the drawing current I1.

[0035] Below, the gestalt of the 5th operation is explained. Drawing 1212 is a block diagram showing the 5th configuration of the gestalt of operation. That is, also in the gestalt of which the above-mentioned operation, although the adjustment which brings the configuration of the drawing current I1 shown in drawing 2 or drawing 3 close to the configuration of the amount I0 of offset currents of Photodiode PD is required, in fact, this adjustment supervises the output of a preamp 4, and it is performed so that a wave like drawing 2 (C) may be acquired. However, the output impedance of a preamp 4 was high, and on the other hand, with the measuring instruments 6, such as an oscilloscope for an output monitor, in order to treat the signal of high frequency, its input impedance needed to be low, and the way things stand, it had the situation that the output monitor of a preamp 4 could not be performed. Then, the outgoing end of a preamp 4 is branched and the impedance-conversion circuit 5 is established in the branched outgoing end. By this impedance-conversion circuit 5, the output impedance of a preamp 4 is changed into the low-power output impedance of about 50ohms, and the measuring instrument 6 of a low input impedance is connected. While being able to perform adjustment of the above-mentioned drawing current I1 easily by this, the monitor of a lightwave signal etc. becomes possible.

[0036] In addition, although drawing 5 , drawing 7 , drawing 9 , drawing 11 , and drawing 12 showed the concrete circuit with the gestalt of each operation mentioned above, as long as this is a circuit which does not pass because it illustrated, but attains the same function, it may be other circuitry.

[0037] Moreover, although the offset detector 2 is constituted from a parallel circuit of a capacitor C1 and resistance R1, such a parallel circuit is connected to plurality and a serial, and you may make it constitute the offset detector 2 from a gestalt of each operation mentioned above according to the property of Photodiode PD.

[0038]

[Effect of the Invention] As explained above, in this invention, quantity of electricity showing the amount of offset currents equivalent to the zero level of a lightwave signal is detected among the amounts of currents which the photo detector outputted, and the amount of offset currents is reproduced based on this. And the reproduced amount of offset currents is drawn out from the amount of currents which the photo detector outputted.

[0039] Even if offset of a photo detector goes up, while being able to perform amplitude discernment and being able to perform amplitude discernment also to a same sign continuation input by this, it becomes possible for circuitry to become very easy and to offer the low optical receiving set of power consumption.

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TECHNICAL FIELD

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[Field of the Invention] This invention relates to the optical receiving set with which the offset level rise which originates in the AF response of a photo detector especially was compensated about the optical receiving set which receives a lightwave signal and is changed into an electrical signal.
[0002] In recent years, optical communication attracts attention with increase of the amount of information transmissions. There is an optical receiving set which receives a pulse-like lightwave signal and is changed into an electrical signal as equipment which achieves an important duty in such optical communication.

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PRIOR ART

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[Description of the Prior Art] Generally an AF response is included in the photo detector which constitutes an optical receiving set, this becomes a cause and the offset level of the electrical signal outputted from the photo detector equivalent to the zero level of a pulse-like lightwave signal rises with time amount progress.
[0004] The structure of a photo detector is considered as one of the causes of this AF response. That is, although the cross-section structure of the PIN photodiode which is a photo detector general to drawing 13 is shown, in this drawing, an PIN photodiode consists of three layers, P layers, I layers (depletion layer), and N layer, I layers are inserted between P layers and N layer, and an electrical potential difference is impressed to P layers and N layer. If I layers receive light, a carrier will be generated, it will be accelerated by the electric field by which this is made between P layers and N layer, and an anode [ of a photo detector ] or cathode side will be reached. Input light is changed into an electrical signal by this.
[0005] By the way, although field strength becomes low in the part separated from the impression electrode in the direction of a field, a carrier is generated when light is also equivalent to an I layer part with such low field strength. Without almost being accelerated by electric field, such a carrier is diffused gradually and reaches an anode [ of a photo detector ], or cathode side. Consequently, a photo detector will have a very big time constant. Although the frequency response characteristic of the photo detector in this case is shown in drawing 14 (A), a level difference will arise near a number - 100kHz of numbers.
[0006] If the lightwave signal with which intensity modulation as shown in drawing 14 (B) was performed is inputted into a photo detector with such a frequency response characteristic, an offset level as shown in drawing 14 (C) will output the electrical signal which went up with time amount progress.
[0007] Since the offset level of the electrical signal outputted from a photo detector rises with time amount progress, the following problems arise. The case where 1st optical communication is first used for the data transfer between computers is explained. Since the transmission distance is comparatively short, such a transfer does not require a big dynamic range. Therefore, the cost reduction by simplification of an optical receiving set is aimed at, and a fixed threshold method performs amplitude discernment. By the way, when a fixed threshold method performs amplitude discernment based on the electrical signal with which an offset level rises with time amount progress, as shown in drawing 15 (A), it arises that "0" level of the electrical signal outputted from a photo detector exceeds a threshold. Consequently, as shown in drawing 15 (B), there is a problem of mistaking "0" signals for "1" signal (it being displayed as "an error" all over drawing).
[0008] The 2nd problem is explained below. Although aiming at a low power and making supply voltage of an optical receiving set low is performed, when a large amplitude signal is inputted into a photo detector, the preamp formed in the latter part of a photo detector will be saturated with an optical receiving set with such equipment. In order to avoid this, the logarithmic amplifier format is adopted as the preamp. That is, the input-output behavioral characteristics of a preamp are made to become a flat output to the input more than fixed level, as shown in drawing 16 (A). however, when the signal with

which the amplitude as shown in drawing 16 (B) is large with a signal, and an offset level rises with time amount progress is inputted into this preamp, it is shown in drawing 16 (C) -- as -- original "0" level -- "1" -- level -- approaching -- just -- being alike -- the problem of being in the condition that "1" level and distinction do not stick arises.

[0009] The circuit which detects "0" level variation of a preamp output, returns this to a preamp as a conventional technique which solved such a problem, and canceled offset is known (collection C-502 of the 1995 Institute of Electronics, Information and Communication Engineers electronics society convention drafts). Moreover, there is the conventional technique indicated by JP,6-232916,A and JP,6-232917,A.

[0010]

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## EFFECT OF THE INVENTION

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[Effect of the Invention] As explained above, in this invention, quantity of electricity showing the amount of offset currents equivalent to the zero level of a lightwave signal is detected among the amounts of currents which the photo detector outputted, and the amount of offset currents is reproduced based on this. And the reproduced amount of offset currents is drawn out from the amount of currents which the photo detector outputted.
[0039] Even if offset of a photo detector goes up, while being able to perform amplitude discernment and being able to perform amplitude discernment also to a same sign continuation input by this, it becomes possible for circuitry to become very easy and to offer the low optical receiving set of power consumption.

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TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] However, found in the collection of the Institute of Electronics, Information and Communication Engineers electronics society convention drafts, with the conventional technique, since feedback starts so that "1" level may be brought close to "0" level when "1" level inputs continuously, "1" level may be taken for "0" level. Therefore, it is necessary to restrict the number of same sign continuation with this conventional technique. Moreover, in the conventional technique indicated by JP,6-232916,A and JP,6-232917,A, circuitry is very complicated and there is a problem in viewpoints, such as cost reduction by low-power-izing or simplification of circuitry.
[0011] From such a thing, this invention offers other different means from such a conventional technique as a means to solve the above-mentioned problem accompanying an offset rise of a photo detector.
[0012] This invention is made in view of such a point, the problem of the amplitude discernment impossible accompanying an offset rise of a photo detector is solved, and also to a same sign continuation input, amplitude discernment is possible and a configuration aims at offering an easy optical receiving set.

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MEANS

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[Means for Solving the Problem] In order to attain the above-mentioned purpose in this invention, as shown in drawing 1 , the inputted lightwave signal among the amounts of currents which the photo detector 1 changed into the amount of currents and the photo detector 1 outputted The offset detector 2 which detects quantity of electricity showing the amount of offset currents equivalent to the zero level of a lightwave signal, The optical receiving set characterized by having the current drawing circuit 3 which reproduces the amount of offset currents from quantity of electricity which the offset detector 2 detected, and draws out the reproduced amount of offset currents from the amount of currents which the photo detector 1 outputted is offered.
[0014] In the above configurations, the offset detector 2 consists of parallel connection circuits of a resistor and a capacitor. By choosing the time constant of these parallel circuits appropriately, the offset detector 2 can detect the amount curve [ **** / the curve of the amount I0 of offset currents of the amounts IPD of currents which the photo detector 1 outputted / almost ] I2 of currents, as shown in drawing 2 (A).
[0015] The current drawing circuit 3 creates the drawing current I1 which has the almost same curve as the amount I0 of offset currents as shown in drawing 2 (B) based on this amount curve I2 of currents (namely, "playback of the amount of offset currents" and homonymy), and draws out this drawing current I1 from the amount IPD of currents which the photo detector 1 outputted. Consequently, the current to which compensation of offset as shown in drawing 2 (C) was carried out is inputted into a preamp 4.
[0016] Moreover, as shown in drawing 3 , even when "1" level is inputted continuously, as shown in drawing 3 (A), as for the offset detector 2, the amount curve [ **** / the curve of the amount I0 of offset currents of a photo detector 1 / almost ] I2 of currents can be detected. Therefore, like the above, the current drawing circuit 3 creates the drawing current I1 which has the almost same curve as the amount I0 of offset currents as shown in drawing 3 (B) based on this amount curve I2 of currents, and draws out this drawing current I1 from the amount IPD of currents which the photo detector 1 outputted. Consequently, the current to which compensation of offset as shown in drawing 3 (C) was carried out is inputted into a preamp 4.
[0017] While the problem of the amplitude discernment impossible accompanying an offset rise of a photo detector 1 as mentioned above is solved, an optical receiving set with an easy configuration is offered possible [ amplitude discernment ] also to a same sign continuation input.
[0018]
[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing. First, the principle configuration of the gestalt of the 1st operation concerning the optical receiving set of this invention is explained with reference to drawing 1 . The gestalt of the 1st operation is equipped with the current drawing circuit 3 which reproduces the amount of offset currents from quantity of electricity which the offset detector 2 which detects quantity of electricity which expresses the amount of offset currents equivalent to the zero level of a lightwave signal among the amounts of currents which the photo detector 1 which changes the inputted lightwave signal into the amount of

currents, and the photo detector 1 outputted, and an offset detector 2 detected, and draws out the reproduced amount of offset currents from the amount of currents which a photo detector 1 outputted.
[0019] Drawing 4 is the block diagram showing the 1st detailed configuration of the gestalt of operation. The current drawing circuit 3 consists of electrical-potential-difference buffer 3a and armature-voltage control current source 3b among drawing. The circuit diagram corresponding to this block diagram is shown in drawing 5 .
[0020] In drawing 5 , a photo detector 1 consists of PIN photodiodes PD, and the offset detector 2 is connected to the cathode side of Photodiode PD. The offset detector 2 is the parallel connection circuit of variable resistance R1 and a capacitor C1. The anode side of Photodiode PD is connected to the base of the transistor Q3 which is the input edge of a preamp 4. The node of a photo detector 1 and the offset detector 2 is connected to the base of the transistor Q1 which is the input edge of electrical-potential-difference buffer 3a through resistance R2. Electrical-potential-difference buffer 3a consists of emitter-followers. The outgoing end of electrical-potential-difference buffer 3a is connected to the base of the transistor Q2 which is the input edge of armature-voltage control current source 3b. The collector of the transistor Q2 of armature-voltage control current source 3b is connected to the base of the transistor Q3 of a preamp 4.
[0021] Actuation of the circuit of drawing 5 is explained below. As shown in drawing 2 (A), the parallel connection circuit of variable resistance R1 and a capacitor C1 integrates with the current IPD which flows to Photodiode PD, and detects the electrical-potential-difference value equivalent to the amount curve I2 of currents. Since the configuration of this amount curve I2 of currents changes by changing the resistance of variable resistance R1, it adjusts the resistance of variable resistance R1 so that the configuration of this amount curve I2 of currents may serve as a curve of the amount I0 of offset currents of Photodiode PD, and similarity. In fact, the output of a preamp 4 is supervised, and the resistance of variable resistance R1 is adjusted so that a wave like drawing 2 (C) may be acquired.
[0022] If the electrical potential difference equivalent to the amount curve I2 of currents is inputted into the base of the transistor Q1 of electrical-potential-difference buffer 3a, the electrical potential difference equivalent to the drawing current I1 shown in drawing 2 (B) will occur at the node of the diode D1 connected to the emitter of a transistor Q1, and resistance R3. According to this electrical potential difference, the transistor Q2 of armature-voltage control current source 3b generates a current. This current is equivalent to the drawing current I1 of drawing 2 (B). Since the drawing current I1 flows in the direction which flows into the collector of a transistor Q2, the current (IPD-I1) from which only the drawing current I1 was deducted will flow at the base of a transistor Q3 from the current IPD which should flow at the base of the transistor Q3 of a preamp 4 from Photodiode PD.
[0023] A preamp 4 is the usual configuration of a transimpedance mold. It is the diode which constitutes the logarithmic amplifier format established in order to prevent saturating diode D4 by the input of a large amplitude signal, and diode D3 is the diode for preventing the oscillation by the input of a large amplitude signal.
[0024] Since the configuration of the drawing current I1 can be made almost the same as the configuration of the amount I0 of offset currents also to a same sign continuation input while the problem of the amplitude discernment impossible accompanying the rise of the amount I0 of offset currents of Photodiode PD as mentioned above is solved, amplitude discernment is possible. Moreover, circuitry is easy and IC-ization can also be realized easily.
[0025] Below, the gestalt of the 2nd operation is explained. Drawing 6 R> 6 is the block diagram showing the 2nd configuration of the gestalt of operation, and drawing 7 is a circuit diagram corresponding to this block diagram. In addition, since the 2nd configuration of the gestalt of operation is fundamentally [ as the 1st configuration of the gestalt of operation ] the same, it gives the same reference mark to the same component, and omits the explanation.
[0026] With the gestalt of the 2nd operation, electrical-potential-difference buffer 3c and 3d of amplifier are newly added to the 1st configuration of the gestalt of operation. That is, as shown in drawing 6 , electrical-potential-difference buffer 3c and 3d of amplifiers are added between the offset detector 2 and electrical-potential-difference buffer 3a. If circuitry explains, as shown in drawing 7 R> 7, the node of a

photo detector 1 and the offset detector 2 will be connected to the base of the transistor Q5 which is the input edge of electrical-potential-difference buffer 3c through resistance R9. The outgoing end of electrical-potential-difference buffer 3c is connected to the base of the transistor Q6 which is the input edge of 3d of amplifiers. The collector of the transistor Q7 which is the outgoing end of 3d of amplifiers is connected to the base of the transistor Q1 of electrical-potential-difference buffer 3a. 3d of amplifier is the differential amplifier which can carry out adjustable [ of the gain ] by carrying out adjustable [ of the resistance of variable resistance R16 ].

[0027] The magnitude of the drawing current I1 generated in armature-voltage control current source 3b can be adjusted by adding such electrical-potential-difference buffer 3c and 3d of amplifier, and adjusting the amount of magnification of 3d of amplifier.

[0028] In addition, although adjusted with the gestalt of the 2nd operation towards adding 3d of amplifier and increasing the magnitude of the drawing current I1 It may be better to have made it adjust towards forming the attenuator which can carry out adjustable [ of the magnitude of attenuation ] depending on the size relation between the configuration of the drawing current I1, and the configuration of the amount I0 of offset currents of Photodiode PD instead of 3d of amplifier, and reducing the magnitude of the drawing current I1.

[0029] Below, the gestalt of the 3rd operation is explained. Drawing 8 R> 8 is the block diagram showing the 3rd configuration of the gestalt of operation, and drawing 9 is a circuit diagram corresponding to this block diagram. Since the 3rd configuration of the gestalt of operation is fundamentally [ as the 1st configuration of the gestalt of operation ] the same, it gives the same reference mark to the same component, and omits the explanation.

[0030] The current drawing circuit 3 of the gestalt of the 1st operation is constituted from electrical-potential-difference buffer 3e and resistance R20 by the gestalt of the 3rd operation. If circuitry explains, as shown in drawing 9 , the node of a photo detector 1 and the offset detector 2 will be connected to the base of the transistor Q10 which is the input edge of electrical-potential-difference buffer 3e through resistance R21. The outgoing end of electrical-potential-difference buffer 3e is connected to the end of resistance R20, and the other end of resistance R20 is connected to the base of the transistor Q3 of a preamp 4.

[0031] Below, the drawing current I1 drawn out through resistance R20 is explained from the amount IPD of currents which should flow into the base of the transistor Q3 of a preamp 4. That is, the output of electrical-potential-difference deltaV is obtained in the offset detector 2, and suppose that it inputted into electrical-potential-difference buffer 3e. Since the gain of electrical-potential-difference buffer 3e is "1" theoretically, electrical-potential-difference deltaV gets across to the end of resistance R20 as it is. On the other hand, since a preamp 4 is a transimpedance mold, feedback has started by resistance R7, therefore the potential of the other end of resistance R20 is not changed. Thereby, electrical-potential-difference deltaV will start resistance R20, and the drawing current I1 serves as deltaV/R20. Here, since it has the relation of deltaV**R1, it is set to I1**R1/R20. Therefore, the magnitude of the drawing current I1 can be set up by the ratio of resistance R1 and resistance R20.

[0032] Below, the gestalt of the 4th operation is explained. Drawing 1010 is a block diagram showing the 4th configuration of the gestalt of operation, and drawing 11 is a circuit diagram corresponding to this block diagram. The 4th configuration of the gestalt of operation newly adds electrical-potential-difference buffer 3c of the gestalt of the 2nd operation, and 3d of amplifier to the gestalt of the 3rd operation. Therefore, in explanation of the gestalt of the 4th operation, the same reference mark is given to the same part as the configuration of the gestalt of the 3rd operation, and the gestalt of the 2nd operation, and the explanation is omitted.

[0033] Since 3d of amplifier can draw out and the magnitude of a current I1 can be adjusted with the gestalt of the 4th operation, the resistance of resistance R20 may be immobilization. By using resistance R20 as a fixed resistor, it becomes the configuration which can lose the distributed capacity which narrows a band andis [ IC-] easy toize.

[0034] In addition, the attenuator which can carry out adjustable [ of the magnitude of attenuation ] instead of 3d of amplifier also with the gestalt of the 4th operation is formed, and you may make it

adjust towards reducing the magnitude of the drawing current I1.
[0035] Below, the gestalt of the 5th operation is explained. Drawing 1212 is a block diagram showing the 5th configuration of the gestalt of operation. That is, also in the gestalt of which the above-mentioned operation, although the adjustment which brings the configuration of the drawing current I1 shown in drawing 2 or drawing 3 close to the configuration of the amount I0 of offset currents of Photodiode PD is required, in fact, this adjustment supervises the output of a preamp 4, and it is performed so that a wave like drawing 2 (C) may be acquired. However, the output impedance of a preamp 4 was high, and on the other hand, with the measuring instruments 6, such as an oscilloscope for an output monitor, in order to treat the signal of high frequency, its input impedance needed to be low, and the way things stand, it had the situation that the output monitor of a preamp 4 could not be performed. Then, the outgoing end of a preamp 4 is branched and the impedance-conversion circuit 5 is established in the branched outgoing end. By this impedance-conversion circuit 5, the output impedance of a preamp 4 is changed into the low-power output impedance of about 50ohms, and the measuring instrument 6 of a low input impedance is connected. While being able to perform adjustment of the above-mentioned drawing current I1 easily by this, the monitor of a lightwave signal etc. becomes possible.
[0036] In addition, although drawing 5 , drawing 7 , drawing 9 , drawing 11 , and drawing 12 showed the concrete circuit with the gestalt of each operation mentioned above, as long as this is a circuit which does not pass because it illustrated, but attains the same function, it may be other circuitry.
[0037] Moreover, although the offset detector 2 is constituted from a parallel circuit of a capacitor C1 and resistance R1, such a parallel circuit is connected to plurality and a serial, and you may make it constitute the offset detector 2 from a gestalt of each operation mentioned above according to the property of Photodiode PD.

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[Translation done.]

* NOTICES *



1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

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## DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]
[Drawing 1] It is the principle explanatory view of this invention.
[Drawing 2] (A) is drawing showing the current outputted from a photo detector, (B) is drawing showing the drawing current generated by this invention, and (C) is drawing showing the current inputted into the preamp in this invention.
[Drawing 3] (A) is drawing showing the current outputted from a photo detector at the time of a same sign continuation input, (B) is drawing showing the drawing current generated by this invention at the time of a same sign continuation input, and (C) is drawing showing the current inputted into the preamp in this invention at the time of a same sign continuation input.
[Drawing 4] It is the block diagram showing the 1st configuration of the gestalt of operation.
[Drawing 5] It is drawing showing the circuitry of the gestalt of the 1st operation.
[Drawing 6] It is the block diagram showing the 2nd configuration of the gestalt of operation.
[Drawing 7] It is drawing showing the circuitry of the gestalt of the 2nd operation.
[Drawing 8] It is the block diagram showing the 3rd configuration of the gestalt of operation.
[Drawing 9] It is drawing showing the circuitry of the gestalt of the 3rd operation.
[Drawing 10] It is the block diagram showing the 4th configuration of the gestalt of operation.
[Drawing 11] It is drawing showing the circuitry of the gestalt of the 4th operation.
[Drawing 12] It is the block diagram showing the 5th configuration of the gestalt of operation.
[Drawing 13] It is drawing showing the cross-section structure of a PIN diode.
[Drawing 14] (A) is drawing showing the frequency response characteristic of a photo detector, (B) is drawing showing the lightwave signal inputted into a photo detector, and (C) is drawing showing the electrical signal outputted from the photo detector.
[Drawing 15] (A) is drawing showing the conventional relation between the output of a photo detector, and the threshold for amplitude discernment, and (B) is drawing showing the output of the conventional amplitude discrimination circuit.
[Drawing 16] (A) is drawing showing the input-output behavioral characteristics of the preamp of the conventional logarithmic amplifier format, (B) is drawing showing the wave of the conventional large amplitude signal inputted into this preamp, and (C) is drawing showing the conventional signal wave form outputted from this preamp.
[Description of Notations]
1 Photo Detector
2 Offset Detector
3 Current Drawing Circuit
4 Preamp
IPD The output current of a photo detector
I1 Drawing current

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[Translation done.]

* NOTICES *



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DRAWINGS

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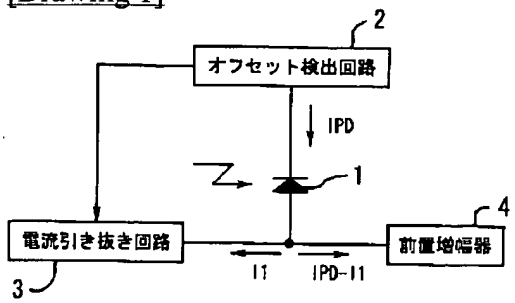
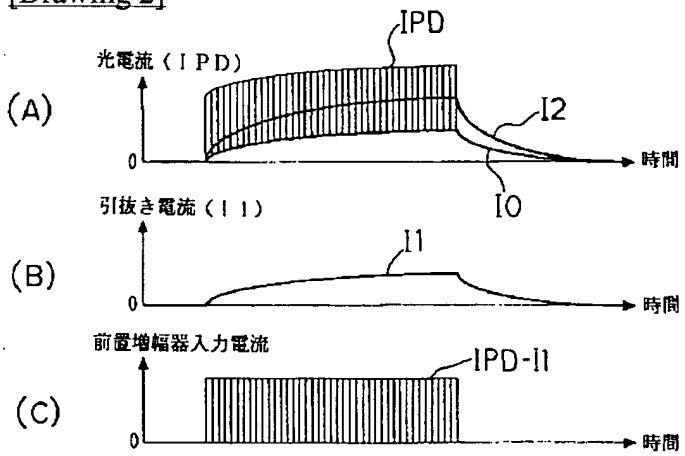
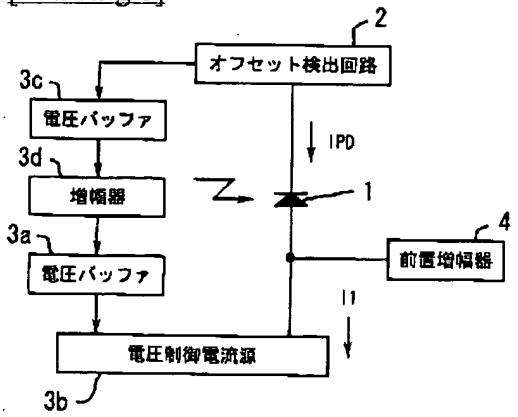
[Drawing 1]



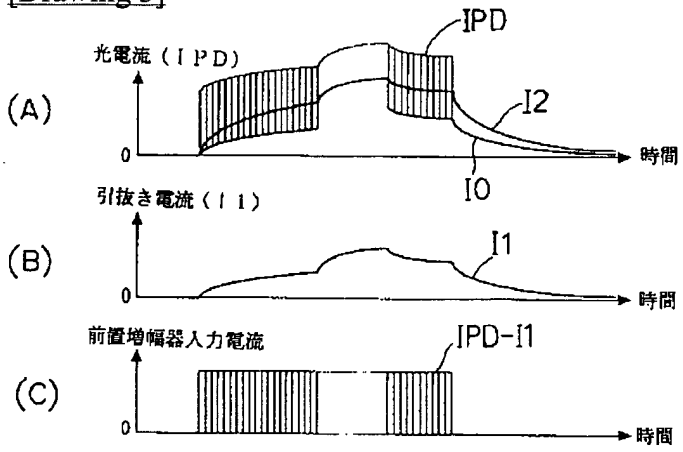

[Drawing 2]



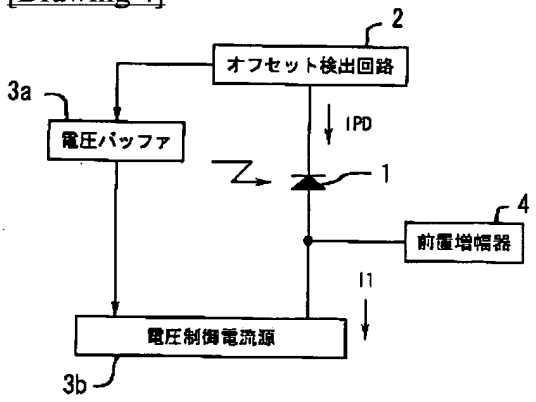

[Drawing 6]



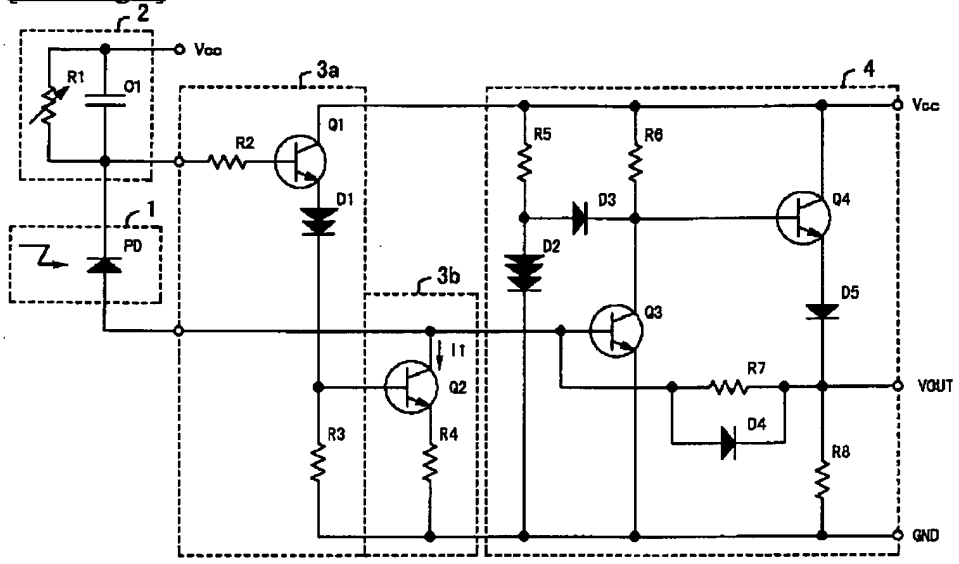
[Drawing 3]



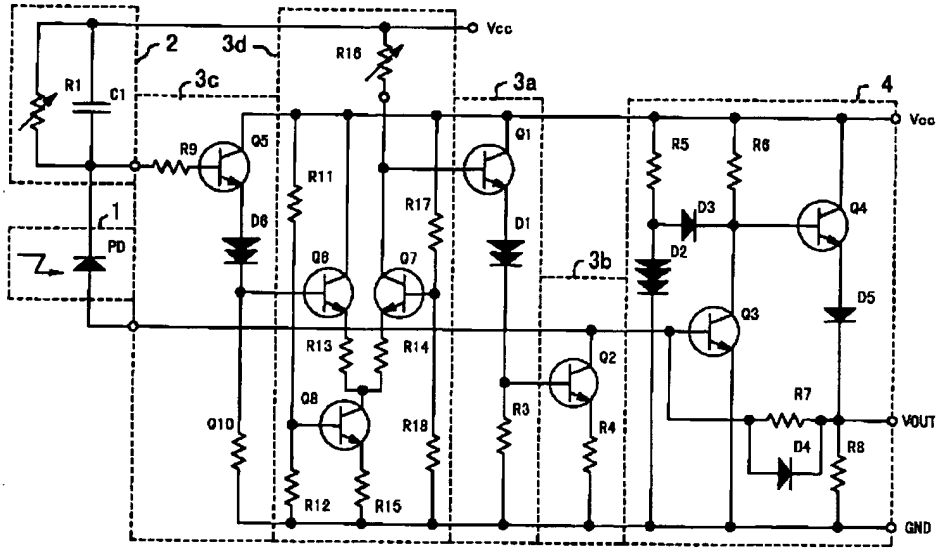

[Drawing 4]



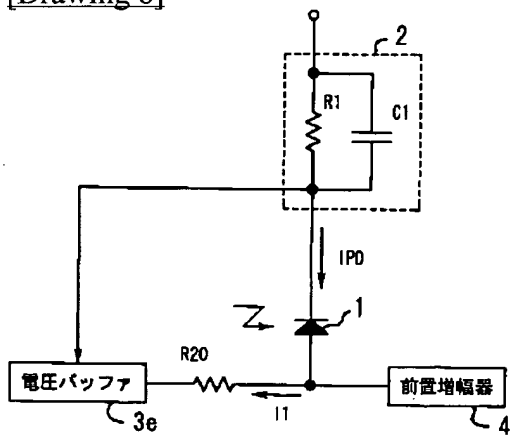

[Drawing 5]



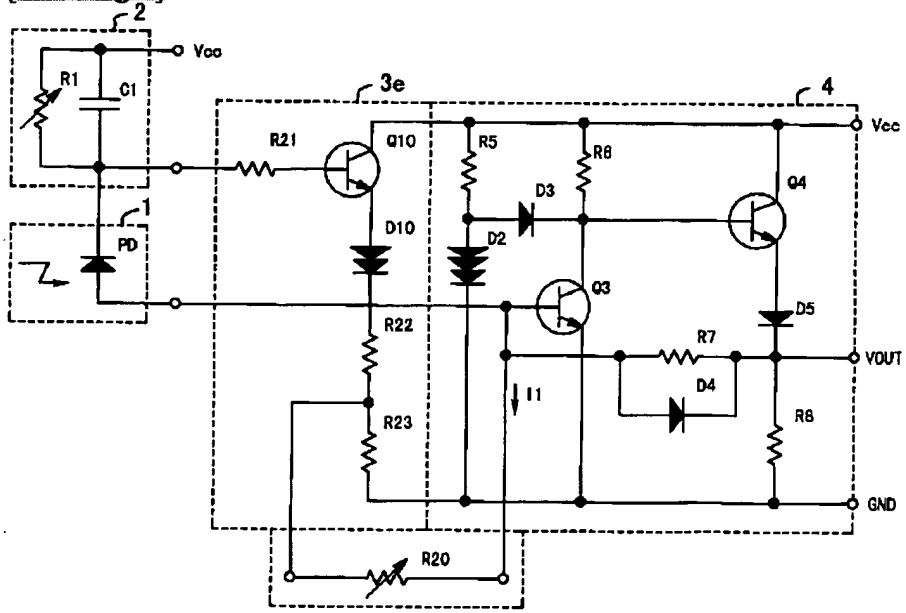

[Drawing 7]



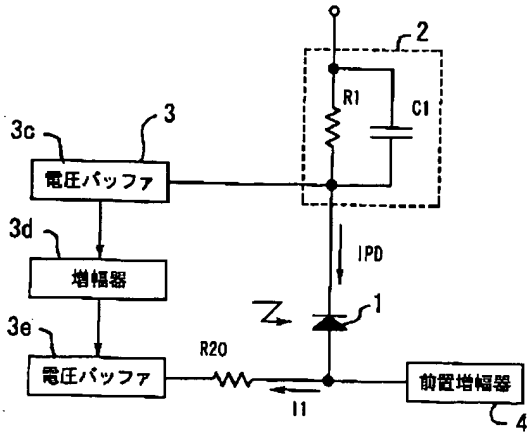

[Drawing 8]



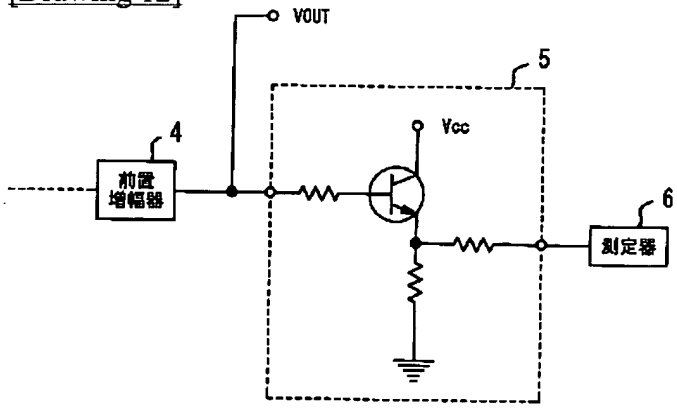

[Drawing 9]



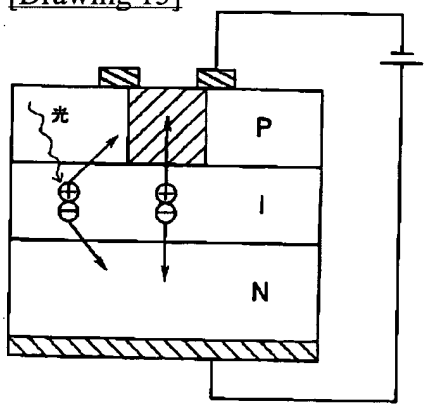

[Drawing 10]



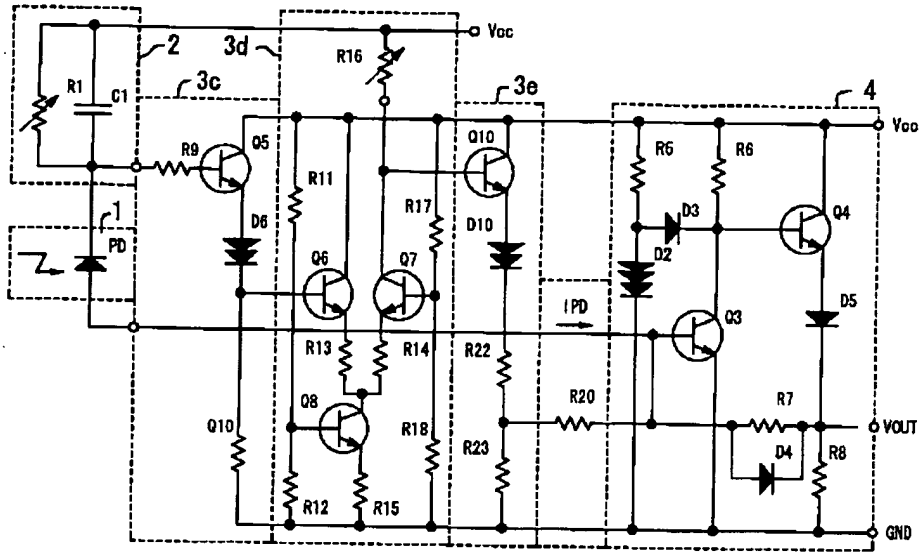

[Drawing 12]



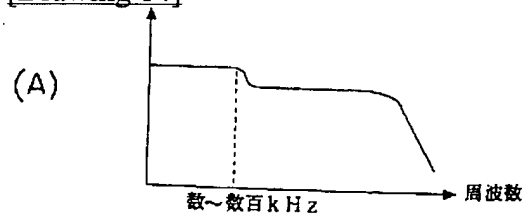

[Drawing 13]

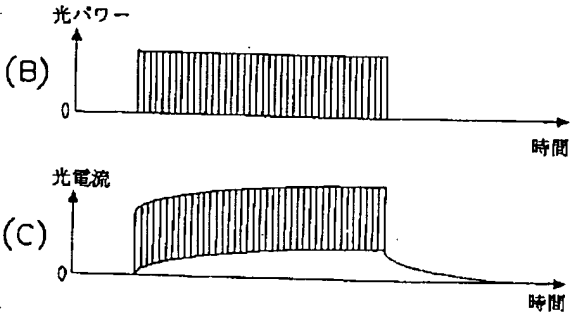



[Drawing 11]

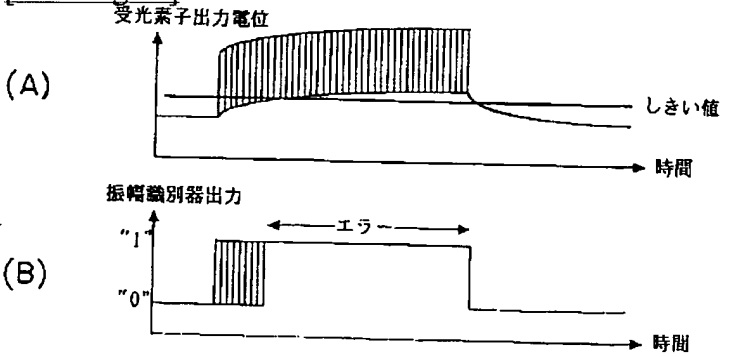



[Drawing 14]

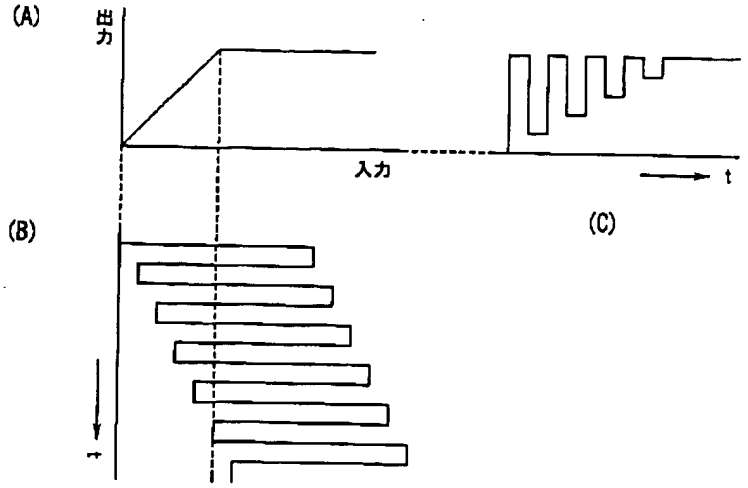



[Drawing 15]




[Drawing 16]




[Translation done.]